TWO-CYCLE INTERNAL COMBUSTION ENGINE

PREAMBLE

[0001] This is a continuation in part based upon utility patent application no. 09,923,414 filed 08/08/2001.

INFORMATION DISCLOSURE STATEMENT

[0002] In preparation for the filing of this application, a pre-examination patent ability search was performed. Among the classes and subclasses reviewed were Class 123, subclass 27R, 65B, 65BA, 68, 198C, 213, 257, 268, 316, 528, 533, 559.1, 561, 565, and 564. Computer searching was also done on the PTO patent database. The search uncovered the following:

Patent No.	Inventor	Date of Issue
6,135,070	R.A. Crandall	Oct. 24, 2000
5,878,703	K. Sweeney	Mar. 9, 1999
5,747,163	E. Green	May 5, 1998
5,388,561	H. Cullum, J. Korn	Feb. 14, 1995
5,375,581	G. Alander, H. Hofman	Dec. 27, 1994
5,179,921	V. Filiuzzi	Jan. 19, 1993
4,984,540	K. Morikawa	Jan. 15, 1991
4,860,699	J. Rocklein	Aug. 29, 1989
4,671,218	C. Weiland	Jun. 9, 1987
4,539,938	R.R. Toepel	Sept. 10, 1985
4,398,509	E. Offenstadt	Aug. 16, 1983
2,851,021	G.W. Covone	Sept. 9, 1958
2,708,919	R.D. Wellington	May 24, 1955
2,685,503	V.C. Reddy	Aug.17, 1954
2,365,379	D.F. Caris	Aug. 22, 1944
2,312,661	D. Messner	March 2, 1943
2, 067,984	J. Ross	Jan. 19, 1937
2,062,621	F.A. Truesdale	Dec. 1, 1936

1,720,414	F. Gruebler	July 9, 1929
1,273,667	J.A. Poyet	July 23, 1918
1,220,893	E.A. Rundlof	Mar. 27, 1917

BACKGROUND OF THE INVENTION

[0003] Designs for two stroke internal combustion engines are disclosed in the art that use positive displacement pumps to charge the cylinder with air prior to ignition. Various methods of charging the cylinder with compressed air produced by a positive displacement pump are disclosed in the art. Often a camshaft operated poppet valve closing off the cylinder from the air passage leading from the air compressor to the cylinder is timed by the camshaft to open and allow air from the compressor to enter the cylinder after the power stroke of the engine. By opening this valve early compressed air from the compressor can also be used to scavenge the cylinder of exhaust gases.

[0004] On such design is disclosed in U. S. patent No. 4,671,218 issued to Weiland. In this patent there is disclosed a gear type positive displacement pump used to charge a holding chamber located above the cylinder with compressed air through which a valve stem projects to the valve face that seals the intake port located in the floor of the holding chamber from the cylinder beneath it. A crankshaft driven camshaft actuates the intake valve while the exhaust ports are open, which are located in the cylinder wall just above the face of the piston when the piston is located at bottom dead center, allowing compressed air from the compressor to fill the cylinder and scavenge the cylinder of remaining exhaust gases.

[0005] The blower types described and illustrated in the patents found during a patent search are usually of the Roots type as disclosed in the Toepel Pat. No. 4,539,948 and others, the turbocharger designs as disclosed in the Sweeney Pat. No. 5,878,703 and others, or of the radial type as disclosed in the Rocklein Pat. No. 4,860,699 and others. Only in the Weiland Patent and the Figliuzzi Pat. No. 5,179,921 do we see a positive displacement gear pump used as a means to force air into the engine. Although the Weiland design shows a holding chamber located above the intake valve into which

compressed air collects prior to the intake valve opening there is nothing shown that indicates any intention to ignite the fuel held within this chamber or an understanding of the beneficial effects upon the engines performance by using the passage above the intake valve as the place to initiate combustion.

[0006] In the present described and illustrated invention power production and efficiency advantages are achieved by using a positive displacement gear pump to compress the fuel mixture into the passages located between the compressor and the intake valve sealing the cylinder from these passages and initiating combustion in the passages instead of compressing the fuel mixture in the cylinder between the intake valve and the piston and initiating combustion at the top of the cylinder below the intake valve as is done in all other designs searched.

[0007] The reasons for initiating combustion above the intake valve in a compressor charged internal combustion reciprocating piston engine instead of below the intake valve are several. Unlike other designs this design uses a combustion zone open to incoming air during combustion. By initiating combustion above the intake valve the combustion process occurring within these passages is constantly exposed to the air discharge coming from the compressor. This causes a greatly improved turbulence of the fuel mixture inside of the passages improving the flame propagation and burning process effectiveness and speeding it up. Since additional air is constantly being feed into these passages located above the intake valve additional fuel as well as air can be added to the combustion process after it has been initiated greatly increasing the power generation during each power cycle of the engine.

[0008] Additionally since the positive displacement gear pump is forcing air into the passages and compressing it there the piston is not involved in the intake and compression cycles of the engine. This leaves the piston responsible for only the power and exhaust cycles of the engine allowing the engine to effectively function as a two cycle engine without many of the inherent problems associated with other two cycle engine designs.

[0009] Other two cycle engines normally pass the fuel mixture through the crankcase,

which requires a dry sump and oil mixed with the fuel to provide lubrication to the crankshaft causing lubrication problems in the crankcase and reduces the life of the crankshaft bearings. Two cycle engines of this design suffer from the additional problem of the intake charge and the exhaust charge mixing during the exhaust and intake cycles of the engine reducing the power and efficiency of the engine and increases the emissions produced by the engine.

[0010] In both two and four cycle engines the opening and closing of the intake port produces volumetric efficiency problems and resultant torque production fluxuations as the rpm of the engine changes due to tuning problems caused by the effect of the wave motions as the intake valve opens and closes. In conventional two and four-cycle engines no additional fuel or air is introduced into the cylinder until the power cycle is completed because the intake valve remains closed during the power cycle preventing the addition of air and fuel into the combustion process completely eliminating the additional power and efficiency additional air and fuel will help produce if added to the combustion process. Four-cycle engines require two revolutions of the crankshaft for every power cycle thereby producing twice as much friction per power cycle as a two-cycle engine.

[0011] All of these defects or deficiencies of conventional two and four cycle internal combustion piston or reciprocating engines are overcome by moving the combustion process out of the top of the cylinder below the intake valve into the passages within the cylinder head above the intake valve and between the compressor and using a positive displacement gear pump to compress the fuel mixture into these cylinder head passages and igniting the compressed charge within these passages as the piston reaches top dead center. This allows the combustion forces to open the intake valve releasing combustion products into the cylinder. Then only very high pressure gases pass through the intake port into the cylinder eliminating torque fluxuations due to standing waves created in conventional engine head intake passages. In addition to achieving two-cycle operation in the present invention complete exhaust of exhaust gases is achieved because on the return stroke from bottom dead center to top dead center the piston forces all the exhaust gases

out through exhaust ports located in the cylinder head.

FIELD OF THE INVENTION

[0012] This invention relates to internal combustion engines, specifically two-cycle reciprocating piston engines.

DISCUSSION OF PRIOR ART

[0013] Designs for two-cycle internal combustion engines are disclosed in the art that use positive displacement pumps to charge the cylinder with air prior to ignition. Compressed air is also used to scavenge the cylinder of combustion products during the exhaust cycle of the engine. Often a camshaft operated poppet valve closing off the cylinder from the air passage leading from the air compressor is timed by the camshaft to open and allow the compressed air to enter the cylinder during part of the exhaust cycle to fill the cylinder and push out remaining exhaust gases before the exhaust port closes.

[0014] One such design is disclosed in the U.S. Patent No. 4,671,218 issued to Weiland. In this patent there is disclosed a gear type positive displacement pump used to charge a holding cylinder with compressed air through which a valve stem projects to a valve face that seals the intake port located in the floor of the holding chamber from the cylinder beneath it. A crankshaft driven camshaft actuates the intake valve while the exhaust ports are open, which are located in the cylinder wall just above the face of the piston when it is at top dead center, allowing compressed air from the compressor to fill the cylinder and scavenge the cylinder of remaining exhaust gases.

[0015] While this design appears to be simple and straightforward it has the disadvantage of allowing the intake charge to cool the exhaust gases thus reducing the effectiveness of the catalytic converters used in the engine exhaust system to reduce emissions. In order for this kind of two-cycle engine to retain the high exhaust temperature of the exhaust gases that occur at the bottom of the power stroke no mixing of the intake charge and the exhaust charge is allowed. Mixing of the intake and exhaust charges of the two-cycle internal combustion engine had always been a design mistake, which until now was unavoidable using current technology. The simple solution to this

problem is to move the location of the combustion chamber in the engine from between the intake valve and the piston to between the intake valve and the compressor. In this way the intake valves can close at or before BDC and remain closed until approximately TDC. At BDC exhaust valves located in the engine head can be opened and as the piston returns to TDC it can force the exhaust gases out through the open exhaust ports as is typically done in a conventional four cycle internal combustion engine design.

[0016] Achieving a four cycle type exhaust stroke in a two cycle engine design overcomes one of the greatest obstacles to it's commercialization as a possible replacement for the conventional four cycle engine as currently available in passenger automobiles worldwide. By using a crankshaft driven supercharger or compressor to charge the two cycle engine cylinder the greatest fault of conventional two cycle design is eliminated which is the requirement of mixing the oil with the gasoline to lubricate the crankshaft and rod/piston assembly of the engine.

[0017] Simply by using a gear type air compressor to charge a combustion chamber located in the engine head between the intake valve and the compressor and originating combustion there the two most important obstacles to the commercialization of the two cycle engine as a viable passenger car engine are eliminated. This is because of all the types of compressor/supercharger types illustrated in the patent searched, whether they be radial, Roots, or turbochargers, only the gear pump type of compressor/supercharger is able to withstand and maintain the high pressures developed during combustion in the combustion chamber of a two cycle internal combustion engine which allows the engine designer to expose the gears of the compressor to the combustion process making it possible to eliminate the above mentioned obstacles to passenger car use of a two cycle internal combustion engine. In addition more oxygen can be pumped into the combustion process by the compressor and results in faster burning of the fuel charge creating more energy close to TDC piston position. This feature of the engine's design is inherently a more efficient use of the fuel burned since more pressure is exerted upon the piston face for a longer time as it moves from TDC to BDC.

[0018] In an embodiment using a camshaft operated intake and exhaust valves the

camshaft is located above the compressor and the valve ports are located below the compressor. In this design the valve stems pass through valve guides in the housing located between the two gear shafts of the compressor. This allows the design to appear very similar to a conventional overhead cam four cycle engine and appear to function like one as well with the main exception being that a power stroke occurs each revolution of the crankshaft instead of every other revolution of the crankshaft because it is a two cycle engine design instead of a four cycle engine design.

OBJECTS AND ADVANTAGES

[0019] It is therefore an important object of the present invention to describe and illustrate a two-cycle internal combustion piston engine design that has an exhaust cycle like a conventional four cycle-internal combustion piston engine design that uses a crankshaft driven positive displacement gear type compressor to compress gas and fuel into an overhead cam, overhead valve cylinder head where combustion is initiated and eliminate mixing oil with the gasoline as in a conventional two-cycle internal combustion piston engine design in order to create an efficient, powerful, low emissions two-cycle internal combustion piston engine.

[0020] It is a further object of the invention to describe and illustrate a two-cycle internal combustion piston engine that can add oxygen to the combustion process by compressing the fuel mixture between a compressor and an intake valve or a piston.

[0021] This discussion has outlined some of the more important objects of the invention. These objects should be construed as illustrative of the more obvious features and applications of the present invention. Many more important results may be obtained by applying the disclosing disclosed invention in different ways and modifying it within the scope of the disclosure. Accordingly, by referring to the detailed description and the various embodiments taken together with the accompanying drawings and claims a more complete understanding of the invention may be ascertained.

SUMMARY OF THE INVENTION

[0022] This invention comprises an internal combustion engine cylinder head designed to be used in conjunction with a cylinder block containing reciprocating means

attached to a crankshaft located in a crankcase. One embodiment of this cylinder head has a housing horizontally divided into three sections along the center lines of the camshaft and the positive displacement gear pump and is bolted together for easy installation of the gear shafts and valve train.

[0023] The drive gears, which are powered by the crankshaft and drive the gear shafts and valve train, are located on opposite sides of the cylinder head. The gear train that drives the camshaft is contained within an extension of the housing to which a cover is bolted to seal the gears inside of the cylinder head. This cylinder head uses three overhead valves, two that are timed by the camshaft to open when the piston reaches bottom dead center to allow combustion products to be pushed out of the exhaust ports as the piston returns to top dead center. Dual exhaust passages are formed in the cylinder head leading to two exhaust ports through which exhaust gases flow out of the engine head. A centrally located overhead valve is operated by combustion forces and the camshaft that push it down towards the piston after the piston reaches top dead center opening the intake port allowing combustion products into the cylinder out of the combustion passages located within the cylinder head between the compressor and the valve. When this valve opens the burning fuel mixture and combustion products flow into the cylinder and force the piston downward. The camshaft controls the closing of this valve.

[0024] Two identical gear shafts having four separate gears on each shaft are meshed together to form four gear pumps within the cylinder head housing. The housing design is intended to position the centerline between horizontal gear shafts of the gear pumps above and centered on the vertical axis of the cylinder in the engine block to which the cylinder head is attached. The two end gear pumps function to pump oil to the bearing surfaces of the gear shafts and camshaft, valve train and to the drive gears attached to the gear shafts, housing and camshaft.

[0025] Coolant passages are formed outside of the compressor housing enclosures and allow coolant to circulate through the cylinder head to transfer heat out of the engine head. The valve guides are positioned along a horizontal line centered between the parallel gear shafts and pass between the gear shafts so that the axis of the centrally

located valve guide is axially aligned with the axis of the piston face. In this arrangement if the center valve pushes down upon the piston face as the valve opens after combustion initiates it pushes upon the center of the piston equally distributing the downward force the valve exerts upon the piston.

[0026] Spark ignition means and fuel injection means are provided in the cylinder head to inject fuel into the combustion passages and ignite the fuel mixture compressed into the combustion passages, which are formed within the housing between the compressor discharge and the center valve. These passages are centrally located along the centerline of the compressor discharge to provide the air discharged by the compressor a means to reach the center valve port and an open area within the head in which the spark plug electrode and fuel injector are located. Attachment means such as bolt holes to bolt the cylinder head to the engine block are not shown because a cylinder block designed to use this cylinder head is not disclosed.

[0027] Methods well known in the art may be used to provide the present invention with the required fuel means, cooling means, ignition means, lubrication means, bearing means, attachment means, compressor means, reciprocating means, housing means, air supply means, and exhaust means. In any embodiment of this invention conventional sensor means, transducer means, control means, computer means, electrical means, engine management means, starting and stopping means well known in the art may be employed to produce optimum engine performance, efficiency, and reliability.

BRIEF DESCRIPTION OF THE DRAWINGS (submitted with preliminary drawings)

[0028] FIG. 1 is a side section view through a two-cycle internal combustion engine in accordance with one embodiment of the invention.

FIG. 2 is a side elevation view of the internal combustion engine shown in FIG. 1.

FIG. 3 is a side elevation view of the internal combustion engine shown in FIG. 1.

FIG. 4 is a top plan view of the internal combustion engine shown in FIG. 1.

FIG. 5 is a transverse section view taken through a plane indicated by section line 5 – 5 in FIG. 1.

FIG. 6 is a side section view through a two-cycle internal combustion engine in

accordance with one embodiment of the invention.

FIG. 7 is a top plan view of the internal combustion engine shown in FIG. 1.

FIG. 8 is a side section view through a two-cycle internal combustion engine in accordance with one embodiment of the invention.

FIG. 9 is a partial side section view of the two-cycle internal combustion engine shown in FIG. 8 taken through a plane indicated by section line 9 – 9.

FIG. 10 is a side elevation view of the two-cycle internal combustion engine shown in FIG. 8 in accordance with one embodiment of the engine.

FIG. 11 is a top plan view of the internal combustion engine shown in FIG. 8.

FIG. 12 is a side elevation view of the internal combustion engine shown in FIG. 8.

FIG. 13 is a partial side elevation view of the two-cycle internal combustion engine shown in FIG. 8 in accordance with one embodiment of the invention.

FIG. 14 is a partial side elevation view of the two-cycle internal combustion engine shown in FIG. 8 in accordance with one embodiment of the invention.

FIG. 15 is a partial side elevation view of the two-cycle internal combustion engine shown in FIG. 8 in accordance with one embodiment of the invention.

FIG. 16 is a transverse section view taken through a plane indicated by section line 16 – 16 in FIG. 8.

FIG. 17 is a transverse section view taken through a plane indicated by section line 17 – 17 in FIG. 1.

FIG. 18 is a transverse section view taken through a plane indicated by section line 18 – 18 in FIG. 1.

FIG. 19 is a front wire frame view of the housing of the engine head illustrated in FIG. 25 of a two cycle internal combustion engine.

FIG. 20 is a front wire frame view of the moving parts within the engine head illustrated in FIG. 25 of a two-cycle internal combustion engine.

FIG. 21 is a top wire frame view of the housing of the engine head illustrated in FIG. 25 of a two-cycle internal combustion engine.

FIG. 22 is a top wire frame view of the moving parts of the engine head illustrated in FIG.

25 of a two-cycle internal combustion engine.

FIG. 23 is a side wire frame view of the housing of the engine head illustrated in FIG. 25 of a two-cycle internal combustion engine.

FIG. 24 is a side wire frame view of the moving parts of the engine head illustrated in FIG. 25 of a two-cycle internal combustion engine.

FIG. 25 is a front wire frame view of the head of a two-cycle internal combustion engine according to one embodiment of the invention.

FIG. 26 is a top wire frame view of the engine head illustrated in FIG. 25 of a two-cycle internal combustion engine.

FIG. 27 is a side wire frame view of the engine head illustrated in FIG. 25 of a two-cycle internal combustion engine.

FIG. 28 is a set of conventional means that may be used in design of this engine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0029] Referring now to the drawings in detail, FIG. 1-5 and 18 illustrate a two cycle internal combustion engine constructed in accordance with one embodiment generally referred to by reference number 30. In this embodiment the engine is enclosed by a housing assembly 32 which is formed from two housing sections 34 and 36. Bolts 39 pass through bolt holes 37 in flanges 31 and 33 surrounding sections 34 and 36 and nuts 44 secure the two housing sections 34 and 36 against gasket 43. As clearly illustrated in FIG.1 and 4 an intake port 40 is formed in the top wall of the housing sections 34 and 36. A lower end of intake port 40 connects to two partial cylinders 53 and 54 formed in housing section 34 and in housing section 36. They are parallel with the crankshaft 85 and contain hollow gear shafts 66 and 67 which are meshed together as can be clearly seen in FIGS. 1, 4, and 18. These gear shafts are divided into sections that form five separate gear pumps used to pump all the working fluids of the engine, coolant, fuel, oil, and oxygen. Gear pumps 120 and 121 are located at the ends of the gear shafts 66 and 67 and they pump oil used in the engine. Gear pump 122 can be used to pump fuel used by the fuel injector 52. Gear pump 123 can be used to pump coolant used to cool the engine that passes through coolant passages 61 and 68. Gear pump 124 pumps the air into the

engine and functions as a compressor. Passage means (not shown) carry fluids to their appropriate locations. Seals 130 are spaced between the gear pumps to prevent mixing of the fluids. Gear shafts 66 and 67 have output shafts 62, 63, 64, and 65 extending through holes formed in the outer vertical walls of housing sections 34 and 36 as shown in FIG. 2 and FIG. 4.

[0030] Gear shafts 66 and 67 are crankshaft driven, counter rotating in opposite directions drawing intake air through intake port 40 and force the intake air into passage 50 from which it passes into cylinder 60. Fuel injector 52 projects into passage 50 through rear wall of housing section 34 for injecting fuel into passage 50. Partial cylinders 53 and 54 are centrally connected at their lower side to outlet passage 50 traversing the length of partial cylinders 53 and 54 within housing 34 and 36. Passage 50 extends through internal housing wall 35 to cylinder 60 that contains piston 76. As illustrated in FIG. 1 and FIG. 2 formed within cylinder 60 is horizontally and generally elongated exhaust port 42 passing through housing section 34 and having flat upper and lower horizontal sides and curved vertical sides. The lower horizontal side of exhaust port 42 is aligned horizontally with upper horizontal surface face 74 of piston 76 when piston 76 is positioned at bottom dead center position within cylinder 60.

[0031] As can be clearly seen in FIG. 1 and FIG. 5 piston 76 has an upper exterior horizontal surface 74 and a circular exterior curved surface 75 tangent with the wall of cylinder 60. Piston pin 70 and piston 76 are rotationally connected to connecting rod 79 rotationally connected to rod journal 81 of crankshaft 85.. As can be more clearly seen in FIGS. 2 - 5, crankshaft output shafts 83 and 84 pass through holes in housing sections 34 and 36 for external power transfer from crankshaft 85. Crankshaft output shaft 84 is centrally and fixedly attached to a drive pulley 95. Power transfer belt 92 circumscribes drive pulley 95 and extends around drive pulley 96, which is fixedly attached to output shaft 65 of gear shaft 67. Oil pump 88 pumps oil through passages in the engine to areas requiring lubrication. Coolant flows through water jackets 61 and 68 to remove excess heat from the engine. Throttle plate 100 located in intake port 40 functions as a butterfly valve to control the amount of air the engine receives.

OPERATION OF THE INVENTION

[0032] During operation of the engine the crankshaft output shaft 84 rotates the drive pulley 95 transferring power to drive belt 92 causing drive pulley 96 to rotate. Rotation of drive pulley 96 causes the rotation of gear shaft 67. Teeth of gear shaft 67 move and force the teeth of gear shaft 66 to move forcing rotation of gear shaft 66. Rotation of gear shafts 66 and 67, which are closely confined within partial cylinders 53 and 54 moves air received from intake port 40 along the circumference of partial cylinders 53 and 54 and into passage 50 from which it passes into cylinder 60. As crankshaft 85 rotates crankshaft rod journal 81 pushes rotationally connected connecting rod 79 which pushes the rotationally connected piston pin 70 and piston 76 towards internal housing wall 35, thereby reducing the volume within cylinder 60 and compressing the air held therein into passage 50. When piston 76 reaches approximately top dead center the fuel injector 52 injects fuel into passage 50 containing the compressed air from the air compressor. High temperature of the compressed air confined within passage 50 ignites the incoming fuel from fuel injector 52 and combustion begins.

[0033] Force of combustion transfers energy to the teeth of gear shafts 66 and 67 and to piston 76 simultaneously causing these parts to accelerate. Acceleration of gear shafts 66 and 67 transfers power to their output shafts 62, 63, 64, and 65. Acceleration of piston pin 70 and piston 76 transfers energy to connecting rod 79 which transfers energy to crankshaft 85 thereby transferring power to the crankshaft output shaft 84 which is combined with the power output of gear shaft output shaft 65 through power transfer belt 92 and the associated drive pulleys 95 and 96. As gear shafts 66 and 67 accelerate they pump more air into the engine for combustion causing greater power to be generated. Fuel injector 52 is timed to turn off before piston face 74 of piston 76 passes below exhaust port 42 so the combustion occurring within cylinder 60 can finish before exhaust gases begin to pass out of the engine. Fresh air from the compressor enters cylinder 60 above the face of piston 76 and fills that portion of cylinder 60 with fresh air. As piston 76 moves towards top dead center air between gear shafts 66 and 67 and piston 76 is 14

again compressed into passage 50 making the engine ready for another power stroke.

DESCRIPTION AND OPERATION OF AN ALTERNATIVE EMBODIMENT

[0034] FIGS. 6 and 7 illustrate a different embodiment of the described invention. FIG. 6 shows the embodiment wherein a poppet valve 105 seals passage 50' from cylinder 60'. Valve stem of valve 105 projects upwards through sections 34' and 36' into a compartment 108 containing helical spring 106, retainer 107, and keeper 111 that keep valve 105 tensioned against the lower wall of passage 50'. When combustion of the fuel and air in passage 50' occurs the force of combustion pushes valve 105 down against the face of the piston 76' forcing it towards bottom dead center. Burning fuel mixture flows into cylinder 60' through the valve port and continues to force piston 76' towards BDC as the valve closes. At BDC the piston 76' uncovers the exhaust port 42' and exhaust gases escape through it from the cylinder 60'. Valve 105 closes when the fuel injector 52' (not shown) stops injecting fuel into the engine at which time the fresh air from the compressor flowing into passage 50' burns out the remaining fuel within passage 50'. Throttle butterfly valves 101 and 102 control the amount of air flowing into the engine. Screw on cap 104 covers the compartment 108. Valve stem of valve 105 passes through valve guide 110A .

[0035] FIGS. 8 - 17 illustrate a two cycle internal combustion engine constructed in accordance with one embodiment generally referred to by reference number 30'. In this embodiment the engine is enclosed by a housing assembly 32' which is formed from three housing section 34A, 36A, and 38. Bolts 39A pass through vertical bolt holes 37A near the corners in sections 34A and 36A and thread into threaded bolt holes 37A passing through section 38 thereby bolting the three housing sections securely together. As clearly illustrated in FIG. 8 and FIG. 11 an intake port 40'' is formed in the top wall of housing section 34A and fuel injector 52' injects fuel into intake port 40''.

[0036] Lower end of intake port 40'' connects to two parallel partial cylinders 53' and 54' formed in the bottom of the housing section 34A and in the top of housing section 36A. They are parallel with the crankshaft 85' and contain hollow gear shafts 66' and 67' which are meshed together as can be clearly seen in FIGS. 11, 16, and 17. Gear shafts 66'

and 67' have output shafts 62', 63', 64', and 65'extending through holes formed in the outer vertical walls of housing sections 34A and 36A. Gear shafts 66' and 67' are crankshaft driven, counter rotating in opposite directions drawing intake air through intake port 40'' and force the intake air into passage 50'' from which it passes into cylinder 60''. Partial cylinders 53' and 54' are centrally connected at their lower side to outlet passage 50'' traversing the length of partial cylinders 53' and 54' within housing section 36A and extends through internal wall 35' to cylinder 60'' that contains reciprocating part 77.

[0037] As illustrated in FIG. 8 and FIG. 12 formed within the cylinder 60'' is a horizontal generally elongated exhaust port 42A passing through housing section 36A and having flat upper and lower horizontal sides and curved vertical sides. Lower horizontal side of exhaust port 42A is aligned horizontally with the upper horizontal surface face 74A of reciprocating part 77 when reciprocating part 77 is positioned at BDC within cylinder 60''. As can be more clearly seen in FIG. 8 and FIG.9 reciprocating part 77 has an upper exterior horizontal surface face 74A, a circular vertical exterior surface 73 that is tangent with the walls of cylinder 60'' and also has a lower depending section 78. Lower depending section 78 has a transverse bearing hole 71' formed therein surrounding rod journal 81' of crankshaft 85A. Upper section of reciprocating part 77 has a sectioned ball shape having a slightly smaller diameter than the cylinder diameter so it can rotate and slide within the cylinder 60'' with lower depending section 78 acting as a lever arm that forces the rotation of the upper section having circular vertical surface73. Reciprocating part 77 and crankshaft 85A are assembled together so the reciprocating part 77 can be one solid part. When crankshaft 85A rotates reciprocating part 77 rotates and the exterior circular surface 73 rotates as it slides up and down the wall of cylinder 60'' allowing constant contact with the wall of cylinder 60''.

[0038] As can be seen clearly in FIG. 9, FIG. 10, and FIG. 12 crankshaft output shafts 83' and 84' pass through holes in housing section 36A and 38 for external power transfer from the crankshaft 85A. Crankshaft output shaft 84' is centrally and fixedly attached to a drive pulley 95'. Power transfer belt 92' circumscribes drive pulley 95' and extends

around drive pulley 96' which is centrally and fixedly attached to the output shaft 65' of the gear shaft 67'.

OPERATION OF THE INVENTION

[0039] During operation of the engine the crankshaft output shaft 84' rotates drive pulley 95' transferring power to drive belt 92' causing drive pulley 96' to rotate. Rotation of drive pulley 96' causes rotation of gear shaft 67'. Teeth of gear shaft 67' move and force the teeth of gear shaft 66' to move forcing rotation of gear shaft 66'. Rotation of gear shafts 66' and 67', which are closely confined within parallel partial cylinders 53' and 54' moves air into passage 50'' from which it passes into cylinder 60''. As crankshaft 85A rotates crankshaft rod journal 81' pushes rotationally connected reciprocating part 77 towards internal housing wall 35', thereby reducing the volume within cylinder 60'' and compressing the air held therein into passage 50''. When reciprocating part 77 reaches approximately top dead center the fuel injector 52' injects fuel into the incoming air stream within intake 40'' and the fuel flows with the air into the air compressor. Positive displacement air compressor discharges the fuel and air mixture received form intake port 40'' into passage 50'' containing the compressed air from the compressor. High temperature of the compressed air confined within passage 50'' ignites the incoming fuel mixture from the compressor and combustion begins.

[0040] Force of combustion transfers energy to the teeth of gear shafts 66' and 67' and to reciprocating part 77 simultaneously causing these parts to accelerate. Acceleration of the gear shafts 66' and 67' transfers power to their output shafts 62', 63', 64', and 65'. Acceleration of the reciprocating part 77 transfers energy to crankshaft 85A thereby transferring power to the crankshaft output shaft 84' which is combined with the power output of gear shaft output shaft 65' through power transfer belt 92' and associated drive pulleys 95' and 96'. As gear shafts 66' and 67' accelerate they pump more air onto the engine for combustion causing greater power to be generated. Fuel injector 52' is timed to turn off before the face 74A of reciprocating part 77 passes below the exhaust port 42A so the combustion occurring within cylinder 60'' can finish before exhaust gases begin to pass out of the engine. Fresh air from the compressor enters cylinder 60'' and scavenges

it of exhaust gases while exhaust port 42a is exposed to the volume of cylinder 60'' above the face of reciprocating part 77 and fills that portion of cylinder 60'' with fresh air. As reciprocating part 77 moves towards top dead center air between gear shafts 66' and 67' and reciprocating part 77 is again compressed into passage 50'' making the engine ready for another power stroke.

DESCRIPTION AND OPERATION OF ALTERNATIVE EMBODIMENTS

[0041] FIG. 13, 14, and 15 illustrate different embodiments of the described invention. FIG. 13 shows an embodiment wherein the fuel is injected into intake port 40''' and ignition means 41''' is placed in the wall of passage 50''' for igniting the fuel mixture in passage 50'''. FIG. 14 shows the embodiment wherein fuel is injected into passage 50'''' instead of into intake port 40'''' by fuel injector 52''' which is located in the rear wall of passage 50''''. In this embodiment is illustrated in FIG. 17, taken through section lines 17 in FIG. 14 two sets of gears to each side of the compressor gears positioned in partial cylinders 53'' and 54''. These two gear sets are comprised of gears 110, 112, 114, and 116 which are submersed in oil to reduce wear and serve to function as a means to control the rate of wear of the main compressor gears. The gears 110, 112, 114, and 116 can be used to pump cooling oil through the hollow gear shafts, through the engine to provide lubricating oil to moving parts requiring lubrication and through an oil cooler. Oil control rings 103 and 109 block oil from escaping from partial cylinders 53'' and 54'' confining gears 110, 112, 114, and 116. FIG. 15 shows an embodiment in which ignition means 41'' projects into passage 50''''' and a fuel injector (not shown) injects fuel into the opposite end of passage 50''''' instead of intake port 40'''''.

DESCRIPTION AND OPERATION OF ANOTHER ALTERNATIVE EMBODIMENT

[0042] Another embodiment is illustrated in FIGS. 19 - 27. These drawings illustrate the two cycle internal combustion engine's cylinder head and cylinder heads internal parts constructed in accordance with one embodiment of the invention generally referred to by reference number 119. In this embodiment the engine's cylinder head is enclosed by a housing assembly 140 which is formed from three head sections, 220, 820, and 1020 horizontally divided. Bolts 230 pass through bolt holes 190 located in the top exterior

surfaces of head sections 820 and 1020 and thread into threaded bolt holes 190 in head section 220 and head section 820 to secure the housing sections together. Horizontal rectangular intake ports 200 and 1230 are formed in the lower head section 220 and centrally positioned above a circular spark plug hole 150 centrally located between the opposite sides of lower head section 220 of housing assembly 140 and project through lower head section 220 from the illustrated side to the opposite side. Fuel injector 52'''''' and spark ignition means 41''' are located within hole 150 to inject fuel and ignite it at the proper times. Intake port 200 connects to horizontal intake passage 240 and intake port 1230 connects to horizontal intake passage 1240 on the opposite of lower head section 220. Intake passage 240 connects to partially circular air intake passage 250 and horizontal intake passage 1240 connects to partially circular intake passage 1250. Air intake passage 250 is radially positioned around partial cylinders 470 and 480 and aligned with the axis of partial cylinders 470 and 480. Intake air passage 1250 is radially positioned around partial cylinders 1470 and 1480 and axially aligned with the axis of partial cylinders 1470 and 1480. Gear shaft 260 having center hole 760 is axially aligned with the axis of partial cylinders 470 and 480 and the wall of the partial cylinders 470 and 480 is very closely spaced from the outer diameters of the gears of gear shaft 260.Gear shaft 1260 having center hole 1760 is axially aligned with the axis of partial cylinders 1470 and 1480 and the wall of partial cylinders 1470 and 1480 is very closely spaced from the outer diameter of the gears of the gear shaft 1260. Intake air passing through air passages 250 and 1250 transfers heat received from cylinder head walls surrounding the air passages 250 and 1250 thereby cooling the cylinder head.

[0043] As illustrated in FIGS. 21, 22, and 24 gear shafts 260 and 1260 are divided into four gear sections on each shaft by five bearing sections 270, 280, 290, 300, and 310 on gear shaft 260 and five bearing sections 1270, 1280, 1290, 1300, and 1310 on gear shaft 1260. Two positive displacement oil pump gears 320 and 350 are located near the ends of gear shaft 260. Two positive displacement oil pump gears 1320 and 1350 are located near the ends of gear shafts 1260. Two positive displacement fuel feed gears 330 and 340 are located oil pump gears 320 and 350 on gear shaft 260. Two positive

displacement fuel feed gears 1330 and 1340 are located between oil pump gears 1320 and 1350 on shaft 1260.

[0044] Positive displacement oil pumps 530 and 1530 are located near the ends of gear shafts 260 and 1260. Positive displacement fuel feed gear pumps 540 and 1540 are located between oil pumps 530 and 1530 on gear shafts 260 and 1260. Positive displacement pumps 530, 540, 1530, and 1540 are formed by meshing together the eight gears located on gear shafts 260 and 1260. Housing bearing holes 410 and 1410, 420 and 1420, 430 and 1430, 440 and 1440, 450 and 1450, pass horizontally through walls 360, 370, 380, 390, and 400 respectively of middle head section 820 and lower head section 220 to provide bearing support for gear shaft bearing surfaces 270, 280, 290, 300, and 310 of gear shaft 260 and bearing surfaces 1270, 1280, 1290, 1300, and 1310 of gear shaft 1260.

[0045] As illustrated in FIGS. 19, 21 and 22 horizontal partial cylinders 460 and 1460 formed in middle head section 820 and lower head section 220 between walls 360 and 370 surround positive displacement oil pump 530. Horizontal oil inlet hole 500 passing through wall 360 provides oil access to oil pump 530. Horizontal oil outlet hole 510 passing through wall 360 provides oil access to gear shaft drive gear 650 fixedly attached to the end of gear shaft 1260 by key 690. Gear shaft drive gear 650 is rotationally connected to the crankshaft of the engine by a chain (not shown) that drives gear 650. Upon crankshaft rotation drive gear 650 rotates imparting rotation to attached gear shaft 1260 that drives meshed gear shaft 260.

[0046] As illustrated in FIGS. 19, 20, 21, and 22 horizontal partial cylinders 470 and 1470 formed between wall 370 and wall 380 surround positive displacement fuel feed gear pump 540. Partial cylinders 470 and 1470 connect to air connection passage 570 formed between partial cylinders 470 and 1470 at their upper tangency. Upper sides of passage 570 connect to the upper ends of partial circular air passages 250 and 1250. Intake air passes from air passages 250 and 1250 through passage 570 to positive displacement fuel feed gear pump 540 that pumps air received from air connection passage 570 into horizontal combustion passage 590 located between vertical internal

wall 370 and vertical combustion passage 610. Air flows from passage 590 into vertical combustion passage 610 passing downward and then into cylindrical combustion passage 630 located between the horizontal plane of the bottom of valve guide 970 and the top of valve face 1000. Combustion passage 630 surrounds and is axially aligned with the axis of valve stem 940 of valve 910 and has an outer diameter smaller than the inner diameter of valve seat 1040.

[0047] As illustrated in FIGS. 19, 20, 21, and 22 horizontal partial cylinders 480 and 1480 formed between wall 380 and wall 390 surround positive displacement fuel feed gear pump1540. Partial cylinders 480 and 1480 connect to air connection passage 580 formed between partial cylinders 480 and 1480 at their upper tangency. Upper sides of passage 580 connect to the upper ends of partial circular air passages 250 and 1250. Intake air passes from air passages 250 and 1250 through air connection passage 580 to positive displacement fuel feed gear pump 1540 that pumps air received from air connection passage 580 into horizontal combustion passage 600 located between vertical internal wall 440 and vertical combustion passage 620. Air flows from passage 600 into vertical combustion passage 620 passing downward and then into cylindrical combustion passage 630 located between the horizontal plane of bottom of valve guide 970 and the top of valve face 1000.

[0048] As illustrated in FIGS. 19, 21, and 22 horizontal partial cylinders 490 and 1490 formed in middle head section 820 and lower head section 220 between wall 390 and wall 400 surround positive displacement oil pump 1530. Horizontal oil inlet hole 1500 passing through wall 400 provides oil access to oil pump 1530. Horizontal oil outlet hole 1510 passing through wall 400 provides oil access to camshaft drive gear train 640. Upon rotation of gear shaft 260 drive gear 660 rotates and drives idler gear 700 rotating on journal 730 and meshed with drive gear 660. Idler gear 700 is meshed with camshaft drive gear 680 having central hole 185 and imparts rotation to gear 680 causing camshaft 740 rotate upon rotation of gear shaft 260. Camshaft drive gear train 640 is comprised of drive gear 660, idler gear 700, and cam drive gear 680 contained inside gear train housing compartment 1750. Gear train housing compartment 1750 enclosing gear train 640 is

formed in housing extension 750 of the lower, middle and upper head sections 220, 820, and 1020 and is covered by flat plate gear train housing extension cover 770 having bolt holes 190 through which bolts 210 thread into bolt holes 190 formed in gear train housing extension 750. Oil hole 710 located in the side of gear train housing compartment 1750 passes through wall 400 and provides oil to camshaft compartment 730. This drive means can be configured to cause greater or less rotation of the air compressor gear shafts (one rotation of gear shafts 260 and 1260 is illustrated per rotation of the camshaft) for each rotation of camshaft 740 to affect the distribution of heat absorbed by the compressor gear shafts, affect compression of the fuel mixture or cause supercharging during engine operation.

[0049] As illustrated in FIGS. 20, 21, 23, and 24 camshaft 740 end bearing surface 830 is supported by blind bearing hole 850 formed in wall 360. Camshaft 740 end bearing surface 840 is supported by bearing hole 860 passing through wall 400 of upper head section 1020 and the middle head section 820 that join at the axial centerline of the blind bearing hole 850 and bearing hole 860. Camshaft 740 has three lobes 870, 880, and 890, which actuate valves 900, 910, and 920 respectively. Valves 900, 910, and 920 are comprised of valve stems 930, 940, and 950 respectively which extend through valve guides 960, 970, and 980 respectively formed in middle and lower head sections 220 and 820. Guides 960, 970, and 980 pass through the center portions of internal walls 370, 380, and 390 formed in middle head section 820 and lower head section 220. Guides 960, 970, and 980 are located between head bearing surfaces 420 and 1420, 430 and 1430, 440 and 1440 respectively, allowing valve stems 930, 940, and 950 to pass between the bearing surfaces 280 and 1280, 290 and 1290, and 300 and 1300 respectively, of gear shafts 260 and 1260 respectively and extend into valve faces 990, 1000, and 1010 respectively. Valve faces 990, 1000, and 1010 upper outer surfaces are tangent with valve seats 1030, 1040, and 1050 respectively, formed in bottom horizontal wall 1400 of lower head section 220. Valve stems 930, 940, and 950 are connected at their upper ends to split keepers 1060, 1070, and 1080 respectively, which have conical shaped outer surfaces which align with the inner conical holes centrally formed through valve retainers 1090,

1100, and 1110 respectively. Retainers 1090, 1100, and 1110 cover valve springs 1120, 1130, 1140 respectively sitting on valve spring washers 1150, 1160, and 1170 respectively, located on the bottom of valve spring seat holes 1180, 1190, and 1200 respectively, formed in upper interior horizontal wall 790 of middle head section 820. Respective valve keepers, retainers, springs, are axially aligned with each valve stem axis. Respective valve washers and valve seat holes are axially aligned with each valve stem axis. Springs 1120, 1130, and 1140 are kept under tension by compressing springs 1120, 1130, and 1140 between the upper horizontal surfaces of washers 1150, 1160, and 1170 and the lower horizontal surfaces of retainers 1090, 1100, and 1110 which are held in position by keepers 1060, 1070, and 1080 inner circular grooves that are aligned with exterior circular grooves formed near the top ends stems 930, 940, 950. Valve faces 990 and 1010 cover exhaust passages 1210 and 1220 and valve face 1000 covers cylindrical combustion passage 630. Exhaust 1210 and 1220 are circular and project upward from valve seats 1030 and 1050 respectively, to internal exhaust passage horizontal walls 800 and 810 respectively, which form the upper walls of internal horizontal rectangular exhaust passages 1380 and 1390 respectively, that extend through lower head section 220 to exhaust ports 1370 and 1360 respectively, formed in the opposing external walls of lower head section 220.

OPERATION OF THE INVENTION

[0050] Upon starting the engine by rotating the crankshaft, gear train 640 causes rotation of camshaft 740 which forces cam lobes 870, 880, and 890 against valve stems 930, 940, and 950. Lobes 870, 880, and 890 are radially positioned around the axis of camshaft 760 and center lobe 880 is oriented to cause middle valve 910 to begin to open approximately upon ignition of the fuel and air mixture in the combustion passages 590, 600, 610, 620, and 630 which is timed to occur approximately when piston reaches top dead center position. Passages 590, 600, 610, 620, and 630 are filled with compressed gas as the crankshaft rotates prior to ignition causing rotation of gear shafts 260 and 1260 for each rotation of crankshaft.

[0051] Rotation of gear shafts 260 and 1260 causes operation of the four gear pumps

530, 1530, 540, 1540 formed by the meshed gears on gear shafts 260 and 1260. Operation of the two positive displacement gear pumps 540 and 15400 force gas into passages 590, 600, 610, 620, and 630 within cylinder head 119 where compression of the gas occurs. Approximate maximum compression of the gas trapped inside passages 590, 600, 610, 620, and 630 is attained as piston reaches top dead center. Fuel injector 52'''''' are shown placed in passages 250 and 1250 upstream of positive displacement gear pumps 540 and 1540 to inject fuel into passages 250 and 1250 and placed inside of hole 150 to inject fuel directly into combustion passage 630 so fuel can be injected into cylinder head 119 at the desired degree of crankshaft rotation to properly supply fuel to the engine. Spark ignition means such as a spark plug 41'''''' is positioned in hole 150 on the opposite side of combustion passage 630 from the side of combustion passage 630 the fuel injector 52'''''' is located within hole 150 to force ignition of the fuel mixture compressed with combustion passage 630 at the desired moment.

[0052] Upon ignition of the fuel mixture combustion occurs within combustion passages 590, 600, 610, 620, and 630 and the burning fuel produces high pressure within the combustion passages 590, 600, 610, 620, and 630 exerting pressure upon the top of valve face 1000 of intake valve 910. The position of intake valve 910 is controlled by the mutual actions of valve spring 1130 and camshaft lobe 880. As intake valve 910 is forced by camshaft 740 downward it moves off valve seat 1040 opening the valve port in the bottom of combustion passage 630 allowing the burning expanding combustion gases to flow into the cylinder equalizing the pressures within the cylinder and passages 590, 600, 610, 620, and 630 to force the piston downwards towards BDC. As the piston and rod assembly moves downward within cylinder under the force of combustion it drives crankshaft which forces the compressor to accelerate because the compressor is driven by rotational drive means (not shown) connecting the crankshaft and the compressor drive gear 650 together. Compressor forces more air into passages 590, 600, 610, 620, and 630 as combustion proceeds causing a faster rate of burning to occur. More fuel can be injected into the engine to feed the combustion process until desired to produce maximum power, efficiency, or low emissions. Valve lifts and durations can be tailored to allow the

desired amount of air into the cylinder during the power stroke of the engine to produce the desired results.

[0053] When piston has reached bottom dead center (BDC) position cam lobes 870 and 890 begin to actuate valves 900 and 920 thereby opening exhaust passages 1210 and 1220 allowing the burned fuel trapped within cylinder to escape through exhaust passages 1210 and 1220 into internal exhaust passages 1380 and 1390 and released out of the engine through exhaust ports 1360 and 1370 as piston returns to the top dead center (TDC) position. Cam lobes 870 and 890 are oriented to close exhaust valves 900 and 920 by the time piston has reached the top dead center position to prevent gas from escaping from cylinder through these exhaust passages during the power stroke of the piston which occurs again as the piston passes the top dead center position.

CONCLUSIONS, RAMIFICATIONS, AND SCOPE OF THE INVENTION

[0054] While the preferred embodiment of the invention have been described and illustrated, it is to be understood that the disclosure is for the purpose of illustration and that various changes and modifications can be made without departing from the scope of the invention as set forth in the appended claims. For example this two-cycle internal combustion engine design can be built as an inline multi cylinder engine, air-cooled radial engine designs, v type engine designs as well as an opposed cylinder (flat) engine designs and even a w type engine designs. It also lends itself to single cycle engine designs in which ignition occurs at both ends of the cylinder and both sides of the reciprocating piston or means.